How to Identify Blister Rust Infection and Resistance in Sugar Pine

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The effort to combat blister rust in sugar pine is an excellent illustration of the positive effect genetic management can have on the viability of an extremely valuable species. This brochure will assist foresters with an important phase of the program, identification of infected and resistant trees.

The Genetic Management Program

The genetic management of important conifers began in California in 1976 with a comprehensive, long-range master plan. This plan aimed to conserve and improve the diversity, health, and productivity of the native genetic resources.

The program's first part -- Base Level -- represents a simple, effective means of low intensity effort to maintain the natural genetic diversity of gene pools while managing the forest. It uses native species and locally adapted seed sources, with a broad gene base of healthy, vigorous seed parents. Base level guidelines are carried out at each ranger district and they can be applied generally to the genetic conservation of any species.

The High Level Program is an intensive selection and breeding effort to maintain genetic diversity and improve desirable traits in managed populations. So far it has been applied to four species: Douglas fir, sugar pine, ponderosa pine, and white fir. However, conservation of valuable traits in other plant species can also be achieved. This program is more complex due to the level of expertise and coordination that is required. It is also linked closely to research and cooperative partnerships. The Pacific Southwest Region Genetic Resource Program is the umbrella for

these tree improvement programs as well as for the genetic management of all plant species in forest ecosystems.

White Pine Blister Rust

The white pine blister rust is a fungal disease of five-needle pines, including sugar pine (*Pinus lambertiana*). It is usually fatal. Blister rust (*Cronartium ribicola*) causes loss of uncountable scenic and esthetic values, food and habitat for wildlife, and hundreds of millions of dollars in commercial timber. The disease was imported from Europe to British Colombia around 1910, and had made its way to northern California by

(Cover) Infected tree showing rust-colored branches (flags) of dead pine needles, plus dead branches within the living crown.

(Figure 2, below) The resistant tree on the left is healthy, with a full crown and new growth, in contrast to the infected tree on the right showing flags and dead branches.

1930. Its life cycle includes annual hosting on gooseberry and currant bushes (*Ribes* spp.). *Ribes* control has not proved effective in controlling blister rust. The fungus spreads from *Ribes* to pine by a small, delicate spore during late summer and fall when extended cool, moist conditions persist.

Not all rust-free trees have resistance nor do all infected trees die. Some exhibit resistance to the disease, plus the ability to repair the damage it does. A goal of the Genetic Resource Program unit stationed on the Eldorado National Forest is to identify genetically resistant sugar pines. These trees are cultivated for seed stock to replant resistant trees in the wild.

(Figure 3, below left) A fresh infection with incipient canker is at the base of the needle fascicle. Rubbing an infection site with water will often enhance the typical orange bark discoloration.

(Figure 4, below right) The most positive sign of infection is the presence of a localized swelling, a canker, on a stem. The fungus has migrated from the needles and begun "feeding" on the cambium layer of the stem. The bark at the upper and lower margins of the canker shows the characteristic orange discoloration where the infection is most active.

The primary indicators of infection are (1) the presence of recently-killed twigs and branches, whose red needles can visually "flag" infected trees; (2) swollen cankers on twigs, branches and trunks where the infection resides and fruiting occurs; (3) orange bark discoloration (most easily seen in spring) at sites of new infection and at the margins of existing cankers.

The following photos and descriptions of symptoms are to help the forest worker locate rust-free trees and identify certain resistance reactions which can be observed in plantations. Trees with bark reactions (Figs. 9-13) should not be harvested or thinned in plantations, but should be reported to the Sugar Pine Genetics Program Manager for breeding.

(Figure 5) Small orange nectar droplets called pycnia exude the first spores formed on an active canker during late spring and summer.

(Figure 6) The white fruiting bodies produce aeciospores in early spring from last year's pycnia. Wind spreads these spores to currants and gooseberries.

(Figure 7) As cankers age through several seasons they enlarge along the stem, with the middle of the canker becoming dark and scarred from previous season's fruiting. The white material is a remnant of fruiting this spring.

(Figure 8) Rodents, birds and insects will feed on the sweet fluid, pycnia, associated with blister rust cankers.

(Figure 9) Bark reaction, a resistance mechanism, dead needle fascicle still attached to infection site. In resistant trees, host cells around the infection die and effectively starve the fungus. The infection does not spread, and green, healthy growth develops below the infection site.

(Figure 10) Bark reaction on a 2-3 year old canker. In this case, the infection spread and a delayed reaction took place.

(Figure 11) Bark reaction and growth of healthy tissue on a 4-5 year old canker.

(Figures 12 & 13) A partial bark reaction, with parts of the canker healing while spore production continues in the area with white fruiting body remnants. This reaction allows the fungus to complete its life cycle and does not kill a healthy, growing tree.

(Figure 14) The dead twig demonstrates another type of resistance reaction -- twig blight. The infected twig dies, isolating the fungus which does not spread.

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